Applications of PVT Systems

3.1 Introduction

PV/T systems are especially suitable for low temperature applications (unglazed collectors in e.g. heat pump systems). For medium temperature applications, the thermal and electrical yield of the hybrid system is lower than that of the two separate systems. This is due to the very basic reason that the solar collector performs best by reaching high temperatures, whereas the PV panel reaches its' maximum yield at low temperatures. The combination of the two will always be a compromise. Hence, a hybrid system is economic viable, when the costs of the reduced energy performance matches the gained costs of production, installation and mounting. Apart from the economic motive, the uniform appearance of the PV/T system may provide an important surplus value in terms of the enhanced architectural aesthetics.

The most important criteria to equally qualify promising hybrid PV/T system and systems of hybrid PV/T will be discussed in this chapter.

Figure 3.1 Application of PVT

3.2 Evaluation Method

The methodology starts with the definition of the most important criteria to equally qualify promising hybrid PV/T system. These criteria are listed in Table 1.

Table 3.1 Evaluation criteria

Criteria	(unit)
Time to market	yr
Market potential	m^2/jr
Investment	/m^2
Building integration	/m^2
Thermal Performance	GJ/yr·m^2
Electrical Performance	kWh$_e$/yr·m^2
Energy consumption	kWh$_e$/yr•m^2
Sustainable building	-
Life time	yr
Effect on energy performance	-

These ten criteria are used to validate eight 'promising' hybrid PV/T systems. The PV/T systems, result from ideas generated during the preceding literature survey and are defined and selected by a panel of experts. The proposed systems are believed to be the most promising systems using today's technology, are applicable to technically feasible within 5 to 10 years in new building projects. The methodology has as a goal to show the real technological and market value of the defined systems.

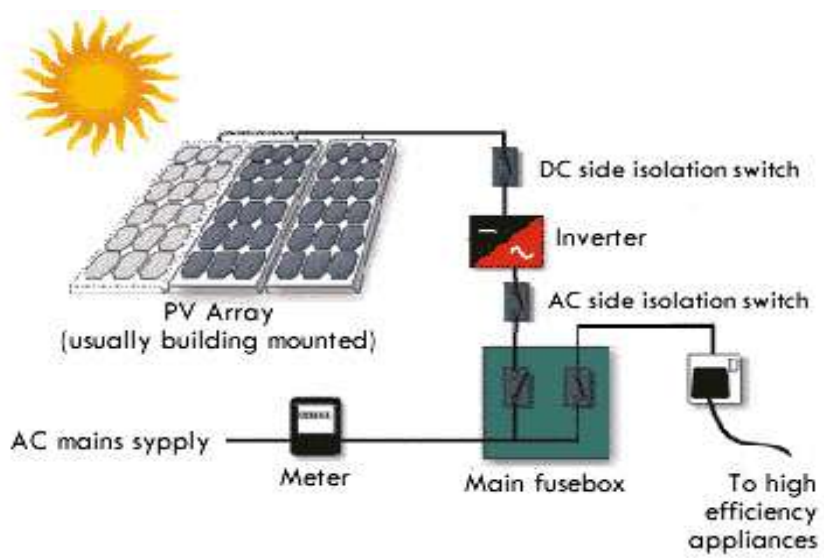

Figure 3.2 PV panels produced electric energy

3.3 Evaluated Hybrid Systems

During the selection of the hybrid systems to be evaluated, emphasis is put on the match between supply and demand of electricity above heat. The following eight systems were assessed.

3.3.1 PV Lighting Applications

PV lighting systems are used for a variety of applications. Ranging from small consumer devices such as flashlights, portable lanterns and low-level walkway lights, to larger structurally-integrated independent power systems, designed to illuminate large surface areas or highway signs. Other PV lighting applications include flashing, signaling and warning devices where the primary function is the luminance, or brightness of the light. Perhaps the most significant application for PV lighting is for residential households and community centers in developing countries. Commonly called solar home systems (SHS), over one million systems have been installed around the world as part of rural electrification programs.

Figure 3.3 PV lighting applications

Table 4 lists common PV lighting system applications and associated key user groups.

Table 3.2 PV Lighting Application Matrix

Principal Function	Lighting Application	User Groups
Area Illumination		
	Parks and recreation areas	Federal, state and local government
	Parking lots	Public and private organizations
	Residential street lighting	Homeowners, developers and utilities
	Pedestrian and bike paths	Municipalities
	Bus stops and shelters	Municipalities and transportation officials
	Security lighting and remote illumination	Utilities and homeowners Public and private organizations
	Storage yards	Public and private organizations
	Portable lighting systems	Contractors Emergency management officials
Sign Illumination		
	Highway information signs	Transportation officials
	Billboards	Advertisers and utilities
	Internally illuminated variable message boards	Transportation officials and contractors
Flashing and Signaling Devices		
	Navigational aids	Navigational authorities
	Highway warning signals	Transportation officials
	Traffic and railway signals	Transportation and railway officials
	Transmission and antenna tower warning lights	Electric utilities Telecommunications and aviation authorities
	Work area protection devices including flashing arrow boards and barricades, etc.	Transportation officials and municipalities Construction contractors
	Signaling systems bridges and other general hazards	Maritime and transportation authorities Public and private organizations
Consumer Products		
	Low-level pathway and landscape lighting	Homeowners and builders
	Rechargeable flashlights	Vehicle and homeowners
	Portable lanterns	Emergency management officials Development/conservation organizations Homeowners
Solar Home Systems		
	Rural residential lighting, remote cabins, restrooms	Development/conservation organizations Rural electrification authorities Homeowners

3.3.2 Solar hot water system & space heating

Identically as in the preceding paragraph, but now the PV/T collector also supplies heat for space heating, meaning a larger roof area to be covered with PV/T.

3.3.3 Solar hot water system

A glazed PV/T collector combines directly the functions of PV (electricity) and a domestic hot water system (hot tap water). The PV panel acts as an absorber in the thermal collector.

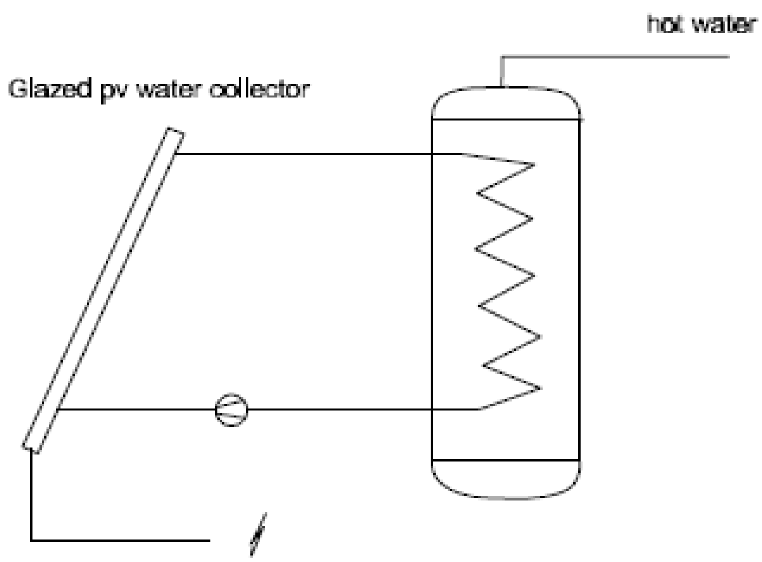

Figure 3.4 Glazed PV/T water collector for tap water heating

3.3.4 PV facade

Building integrated PV in facade offers a relatively simple opportunity to utilize the heat generated in the PV panels. In that case the PV façade acts as an unglazed PV/T air collector and may supply natural ventilation in summer and pre-heated air in winter.

In spring or summer either ventilation or pre-heated air may be supplied, depending of the climate. Applications are foreseen in industrial buildings (e.g. distribution centers), where heating and ventilation are hard to accomplish / have a low priority.

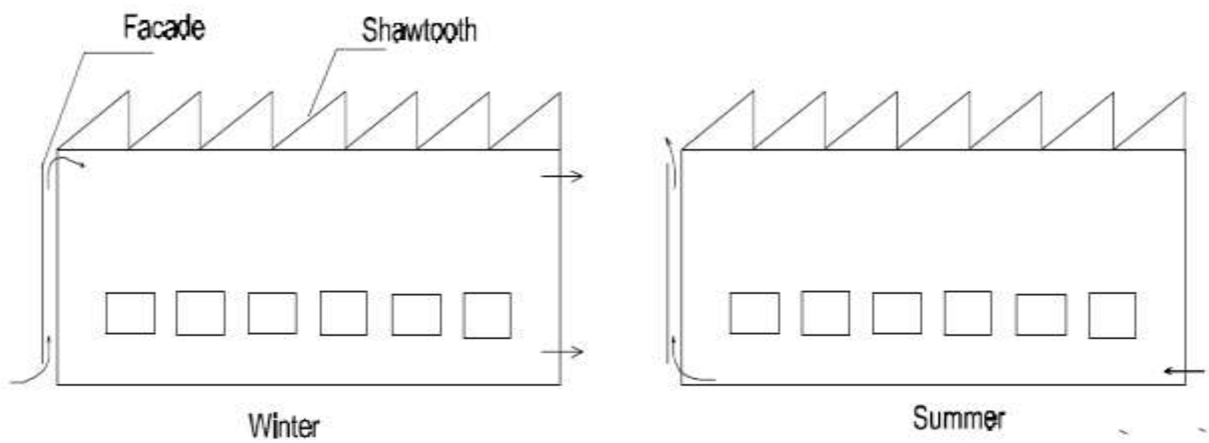

Figure 3.5 Unglazed PV/T air collector as ventilated PV facade in an industrial building

3.3.5 Indoor swimming pool

To heat the water of an indoor swimming pool to max. 30 °C a simply covered PV/T collector will suffice.

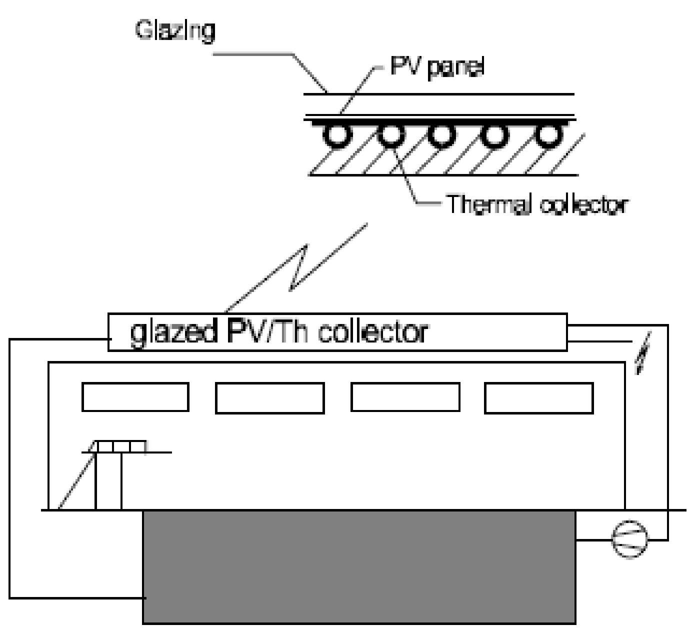

Figure 3.6 Glazed PV/T water collector for pool heating

3.3.6 In- and outdoor swimming pool.

An unglazed PV/T collector can pre-heat the cold water supply (10 °C). During summer times, auxiliary heating is not necessary.

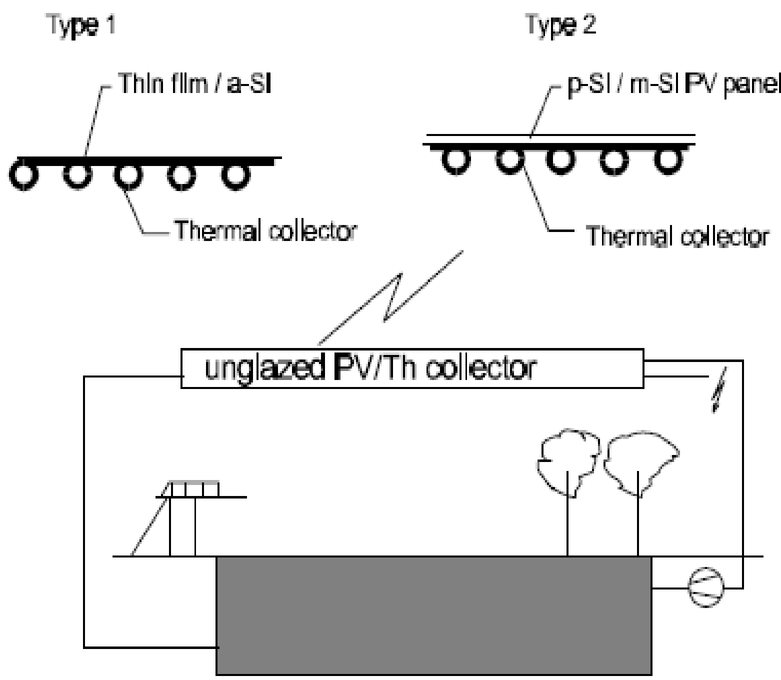

Figure 3.7 Unglazed PV/T water collector for pool heating.

Figure 3.8 Photovoltaic with swimming pool.

3.3.7 Heat pump I

The pre-heated air of the unglazed PV/T collector supplies the heat pump of its heat source.

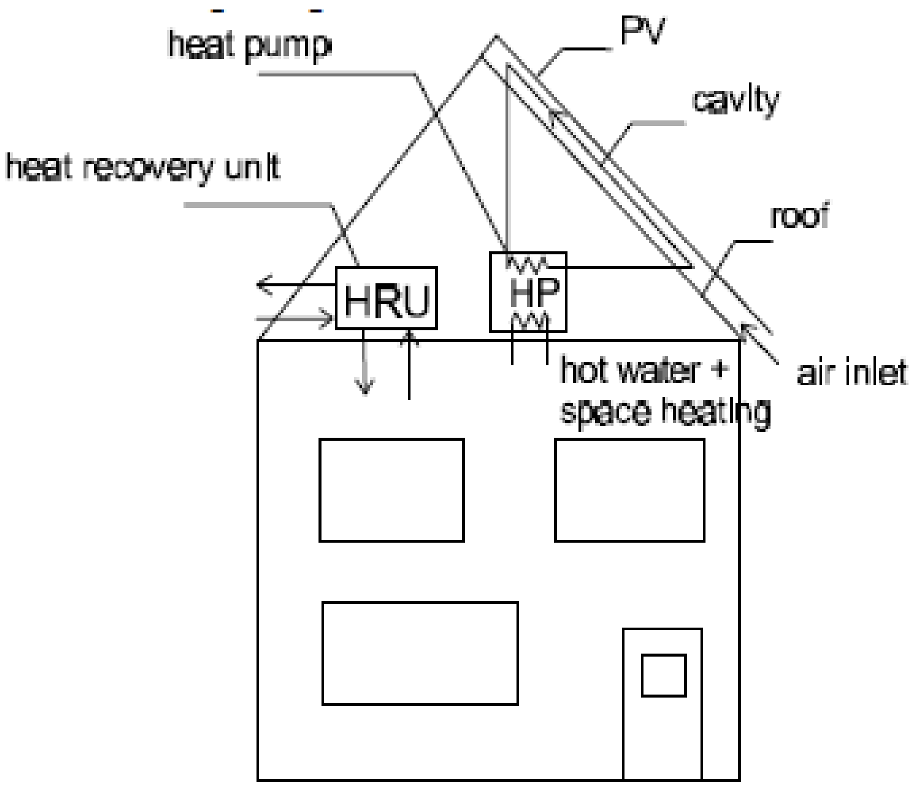

Figure 3.9 Unglazed PV/T air collector combined with a heat pump and heat recovery unit

The heat pump upgrades the pre-heated air to low temperature space heating. Additionally, a heat recovery unit is installed to reduce the heat losses.

3.3.8 Heat pump II

Here, an unglazed PV/T collector is combined with a heat pump and aquifer. In summer, the PV/T collector is cooled with 5~10°C from the aquifer. While cooling the PV/T collector, the water is heated to about 20 °C, and stored in the aquifer to be used as heat source for the heat pump in winter .In winter, the heat pump upgrades the stored heat for low temperature space heating to about 40 °C. (During this process, the aquifer is fed with cold water 5~10 °C again).

This system offers opportunities to regenerate the heat in the soil when heat pumps are used on a large scale in urban areas.

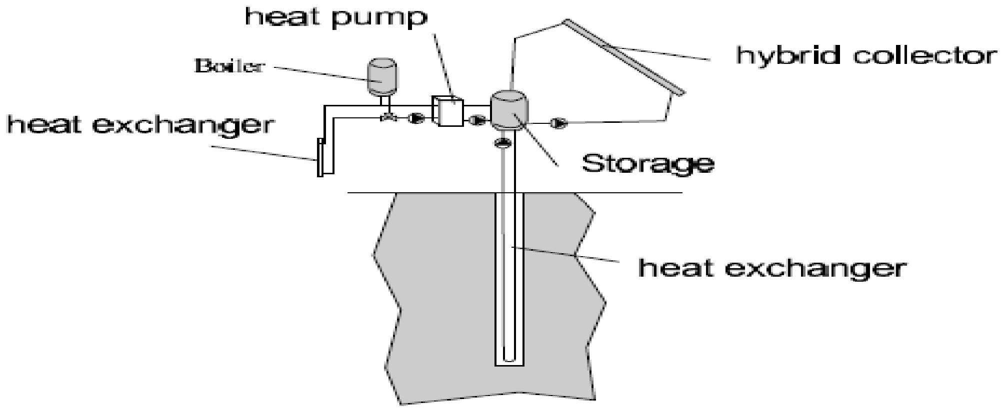

Figure 3.10 Unglazed PV/T water collector combined with a heat pump and aquifer

3.3.9 Biomass dryer

An unglazed PV/T collector can be used to dry biomass (e.g. tulip bulbs and woodchips). Not all industrial drying processes can be utilized by solar energy due to the relatively low energy efficiency and low temperatures.

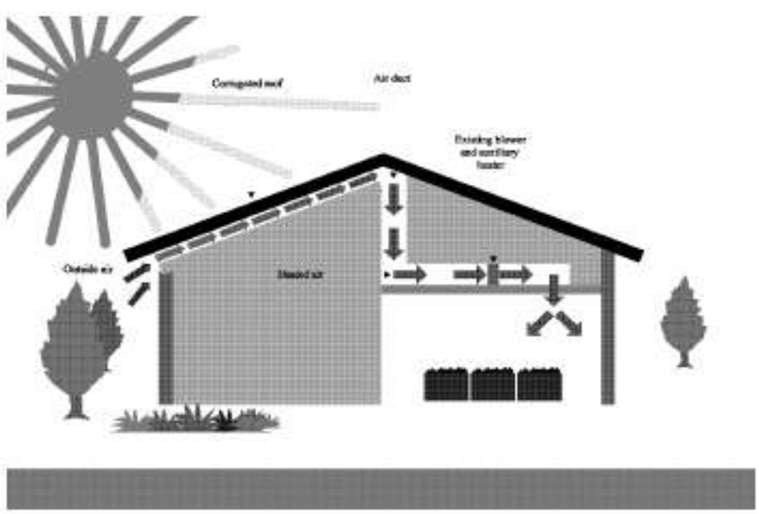

Figure 3.11 Unglazed PV/T air collector for drying tulip bulbs